04-20-00 A

Practitioner's Docket No. 944-003.007 **PATENT**

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): BROR SVARFVAR, TERHO KAIKURANTA, PERTTI NOUSIAINEN, ILPO PYYKKÖ, PENTTI JÄRVELÄ and MARJA RISSANEN

WARNING: *37 C.F.R. § 1.41(a)(1) points out:*

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors."

For (title): EMI SHIELDING FOR PORTABLE ELECTRONIC DEVICES

CERTIFICATION UNDER 37 C.F.R. § 1.10*
(Express Mail label number is mandatory.)
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date April 19, 2000, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL508861778US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Judith Schick
(type or print name of person mailing paper)

Judith Schick
Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. § 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

***WARNING:** Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. § 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

1. Type of Application

This new application is for a(n)

(check one applicable item below)

☒ Original (nonprovisional)

☐ Design

☐ Plant

WARNING: ***Do not*** *use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. § 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

WARNING: ***Do not*** *use this transmittal for the filing of a provisional application.*

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

☐ Divisional.

☐ Continuation.

☐ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. §§ 119(e), 120, or 121)

NOTE: A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. § 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(l) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: *If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. §§ 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. §§ 120, 121 or 365(c). (35 U.S.C. § 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. §§ 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.*

WARNING: *When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application* ***must*** *be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).*

☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed

A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

_18_ Pages of specification

_4_ Pages of claims

_5_ Sheets of drawing

WARNING: ***DO NOT*** *submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. § 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).*

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. § 1.84(c)).

(complete the following, if applicable)

☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. § 1.84(b).

☐ formal

☒ informal

B. Other Papers Enclosed

____ Pages of declaration and power of attorney

_1_ Pages of abstract

____ Other

4. Additional papers enclosed

☐ Amendment to claims

☐ Cancel in this applications claims ________________ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☐ Preliminary Amendment

☐ Information Disclosure Statement (37 C.F.R. § 1.98)

☐ Form PTO–1449 (PTO/SB/08A and 08B)

☐ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)-(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)-(4).

NOTE: "The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.62, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(i) is filed supplying or changing the name or names of the inventor or inventors." 37 C.F.R. § 1.41(a)(1).

☐ Enclosed

Executed by

(check **all** *applicable boxes)*

☐ inventor(s).

☐ legal representative of inventor(s). 37 C.F.R. §§ 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. § 1.47 and the statement required by 37 C.F.R. § 1.47 is also attached. See item 13 below for fee.

☒ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☐ Application is made by a person authorized under 37 C.F.R. § 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 C.F.R. § 1.16(e) can be filed subsequently).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 C.F.R. § 1.41(d))

6. Inventorship Statement

WARNING: *If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.*

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of $130.00 required by 37 C.F.R. § 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 C.F.R. § 1.52(d).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. § 1.52(d).

8. Assignment

☒ An assignment of the invention to NOKIA MOBILE PHONE LTD.

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: *A newly executed "CERTIFICATE UNDER 37 C.F.R. § 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.*

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☐ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. § 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. § 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. § 1.16)

A. ☒ Regular application

CLAIMS AS FILED					
Number filed		Number Extra		Rate	Basic Fee 37 C.F.R. § 1.16(a) $690.00
Total Claims (37 C.F.R. § 1.16(c))	17 − 20 =	0	×	$ 18.00	
Independent Claims (37 C.F.R. § 1.16(b))	3 − 3 =	0	×	$ 78.00	
Multiple dependent claim(s), if any (37 C.F.R. § 1.16(d))			+	$260.00	

☐ Amendment cancelling extra claims is enclosed.

☐ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. § 1.16(d).

Filing Fee Calculation $ 690.00

B. ☐ Design application
($310.00—37 C.F.R. § 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application
($480.00—37 C.F.R. § 1.16(g))

Filing fee calculation $_____

11. Small Entity Statement(s)

☐ Statement(s) that this is a filing by a small entity under 37 C.F.R. § 1.9 and 1.27 is (are) attached.

WARNING: *"Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. § 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).*

WARNING: *"Small entity status must not be established when the person or persons signing the . . . statement can* ***unequivocally*** *make the required self-certification." M.P.E.P., § 509.03, 6th ed., rev. 2, July 1996 (emphasis added).*

(complete the following, if applicable)

☐ Status as a small entity was claimed in prior application

_____ / _____, filed on _____, from which benefit is being claimed for this application under:

35 U.S.C. § ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of **A, B** or **C** above)

$_____

NOTE: Any excess of the full fee paid will be refunded if small entitiy status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 C.F.R. § 1.28(a).

12. Request for International-Type Search (37 C.F.R. § 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☒ Not Enclosed

☐ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. § 1.16(e) can be paid subsequently.)

☐ Enclosed

☐ Filing fee $ ______

☐ Recording assignment ($40.00; 37 C.F.R. § 1.21(h)) (See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".) $ ______

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached ($130.00; 37 C.F.R. §§ 1.47 and 1.17(i)) $ ______

☐ For processing an application with a specification in a non-English language ($130.00; 37 C.F.R. §§ 1.52(d) and 1.17(k)) $ ______

☐ Processing and retention fee ($130.00; 37 C.F.R. §§ 1.53(d) and 1.21(l)) $ ______

☐ Fee for international-type search report ($40.00; 37 C.F.R. § 1.21(e)) $ ______

NOTE: 37 C.F.R. § 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. § 1.53(f) and this, as well as the changes to 37 C.F.R. §§ 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed $______

14. Method of Payment of Fees

☐ Check in the amount of $______

☐ Charge Account No. ______ in the amount of $______.

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. § 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: *If no fees are to be paid on filing, the following items should not be completed.*

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.*

☐ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. ________________:

- ☐ 37 C.F.R. § 1.16(a), (f) or (g) (filing fees)
- ☐ 37 C.F.R. § 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☐ 37 C.F.R. § 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a)).
- ☐ 37 C.F.R. § 1.17 (application processing fees)

NOTE: ". . .A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

- ☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . " From the wording of 37 C.F.R. § 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: ". . . Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

- ☐ Credit Account No. ____________________
- ☐ Refund

Francis J. Maguire (signature)

SIGNATURE OF PRACTITIONER

Reg. No. 31,391

Francis J. Maguire
Ware, Fressola, Van Der Sluys & Adolphson LLP
(type or print name of attorney)

Tel. No. (203) 261-1234

755 Main Street, P.O. Box 224
P.O. Address

Customer No. 004955

Monroe, Connecticut 06468

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

☒ This transmittal ends with this page.

944-003.007

U.S. Patent Application of

BROR SVARFVAR, TERHO KAIKURANTA, PERTTI NOUSIAINEN,
ILPO PYYKKÖ, PENTTI JÄRVELÄ and MARJA RISSANEN

relating to a

EMI SHIELDING FOR PORTABLE ELECTRONIC DEVICES

Express Mail No. EL508861778US

EMI SHIELDING FOR PORTABLE ELECTRONIC DEVICES

Technical Field of Invention

The present invention relates broadly to electromagnetic interference (EMI) shielding and more specifically, but not exclusively, relates to EMI shielding for portable electronic devices such as cellular or radio telephones.

Background of the Invention

The normal operation of electronic equipment such as computers, communications equipment, portable electronic devices such as cellular or radio telephones, and the like is attended by the generation of electromagnetic signals within the electronic circuitry of the equipment. Such electromagnetic signals often develop as a field or as a transient within the radio frequency band of the electromagnetic spectrum, i.e., from between about 10 KHz and 10 GHz, and is termed electromagnetic interference or EMI as being known to interfere with the proper operation of the electronic circuitry of other proximate electronic devices. Cellular or radio telephones in particular are required by law to adhere to Electromagnetic Compatibility (EMC) limits as laid down in Type Approval Specifications for Mobile Phones. "EMC" is defined as the ability of a device to function properly in its intended electromagnetic environment and not to be a source of electromagnetic pollution to that environment.

To reduce or attenuate the effects of EMI, shielding having the capability of absorbing and/or reflecting EMI energy may be employed both to confine the EMI energy within a source device, and to insulate the device or other target devices from other source devices. Such shielding is provided as a barrier which is inserted

between the source and the other devices, and is typically configured as an electrically conductive and grounded housing which encloses the device. As the device generally must remain accessible for servicing or the like, most housings are provided with openable or removable accesses such as doors, hatches, panels, or covers. Typically, there are gaps between the accesses and the corresponding mating surfaces which reduce the efficiency of the shielding by presenting openings through which electromagnetic energy may leak or otherwise pass into or out of the device. Furthermore, such gaps represent discontinuities in the surface and ground conductivity of the housing or other shielding, and may even generate a secondary source of EMI radiation by functioning as a form of slot antenna. Any bulk or surface currents induced within the device housing develop voltage gradients across any interface gaps in the shielding thereby causing the gaps to function as antennae which radiate EMI noise.

One preferred shielding solution is to use a cover or housing shell made of metal to absorb and shield any EMI radiation energy generated by the electronic device. One drawback of such metal covers is additional weight and cost which is added to the electronic device. A further drawback is the inability and difficulty to form the metal sheet to a desired shape and contour of the electronic device housing thereby requiring the electronic device to be larger and less aesthetically pleasing than would otherwise be possible if not for the metal enclosure required for the EMI shielding. One proposed solution to reduce the weight and accommodate the shape and contour of the electronic device is to spray a metallized surface coating on the interior of a lightweight plastic or other suitable lightweight

material forming the electronic device housing. Although this has the advantage of reducing the weight, the cost is increased due to the additional step of applying the metallized coating which complicates the manufacturing process and the cost of the metallic coating itself. Additionally, the metallized coating is easily scratched which reduces its shielding effectiveness.

A further problem is that the mating surface of the electronic device housing covers regardless of the material is not perfectly flat so that mating interfaces provide gaps from which EMI radiation energy can escape. Gaskets and other seals have been proposed for filling the gaps within mating surfaces of housings and other EMI shielding structures while maintaining electrical continuity across the structure. Such gaskets or seals are bonded or mechanically attached to or pressfitted into one of the mating surfaces and function to close any interface gap to establish a continuous conductive path thereacross by conforming under an applied pressure to irregularities between the surfaces. However, even pressure on the gasket interfaces may also generate gaps between the gasket surface and the ground layer and function as slot antenna to radiate EMI noise. In addition, the gaskets are also subject to shielding failures due to problems with compressibility, resiliency, and attachment. Further, there is an increasing demand in new products to make them smaller by reducing the number of screws, fastening devices and contact points which will require a more efficient and cost effective method for EMI shielding to accommodate these demands.

Disclosure of the Invention

Accordingly it is an object of the present invention to provide an efficient and cost effective EMI shielding solution for portable electronic products particularly cellular and radio telephones.

In one aspect of the invention, an EMI shielding solution for a portable electronic device includes an electrically conductive fiber mesh net insert molded into the walls defining an interior cavity of the device to surround and shield first electronic circuitry contained within the device.

In a further aspect of the invention, at least a portion of the fiber mesh net is brought into direct continuous physical and electrical contact with a ground plane carried on a circuit board substrate within the electronic device.

In another aspect of the invention, an EMI shielding solution for a portable electronic device includes an electrically conductive fiber mesh net laminated to a surface of a polymer film sheet.

In a further aspect of the invention, the polymer film sheet has an electrically non-conductive surface opposite the fiber mesh net surface for carrying second electronic circuitry, and at least a portion of the fiber mesh net extends to the non-conductive side for mechanical and electrical coupling to the second electronic circuitry.

In a yet further aspect of the invention, the fiber mesh net is a mixture of conductive and non-conductive fibers with at least one of the conductive fibers carrying electrical signals from the first electronic circuitry on the printed circuit board to the second electronic circuitry.

In a yet further aspect of the invention, the fiber mesh consists of natural fibers or filaments such as cotton and other cellulose fibers, silk or other protein fibers and/or glass or other ceramic fibers.

In a yet further aspect of the invention, the fiber mesh consists of man-made synthetic, regenerated or metal fiber and filaments, such as polyesters, polyamides, polypropylenes, polyethylenes and cellulosics, and particularly suited are PES, PA6.6, PA6, PP and copper. Fibers, filaments, and yarns can be coated by a thin layer of a conductive metal layer thickness of 10-10000nm, and preferably the conductive metal layer is a silver, nickel or aluminum layer. The fiber fineness can be varied from 0.05 den (0.055 dtex) microfiber to 100 den (110 dtex) monofilament whereas the yarn fineness can be extended according to the mesh type up to 300 den (33 tex).

In a yet further preferred aspect of the invention, the fiber mesh net consists of a bobbinet woven 3-directional net having 6 to 34 openings per inch and a specific weight of 10 to 50 grams per square meter.

In further aspects of the invention, the fiber mesh consists of warp knitted, woven, Raschel, braided nonwoven or spun multidirectional nets, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become readily apparent for the following description and drawings wherein:

Fig. 1 is a photo reproduction of an example of a fiber mesh net of the type that may be practiced in the present invention;

Fig. 2 is a magnified view of woven fibers of the fiber mesh net of Fig. 1;

Fig. 3 is a further magnified view of a section of the fiber mesh net shown in Fig. 2 showing the inter-twisting of fibers of the electrically conductive fibers of the fiber mesh net;

Fig. 4 is a photo reproduction of a further example of a fiber mesh net of the type that may be practiced in the present invention;

Fig. 5 is a magnified view showing the pattern of woven fibers of the fiber mesh net of Fig. 4;

Fig. 6 is a photo reproduction of a yet further example of a fiber mesh net of the type that may be practiced in the present invention;

Fig. 7 is a magnified view showing the pattern of woven fibers of the fiber mesh net of Fig. 6;

Fig. 8 is a somewhat schematic edge end view of the fiber mesh nets of Figs. 1, 4 and 6;

Fig. 9 is a somewhat schematic cutaway profile view of a cover structure embodying the insert molded fiber mesh net of the present invention;

Fig. 10 is a partial view showing one cavity of a multi-cavity mold with a fiber mesh net sheet positioned above the cavity for insert molding with a cover structure;

Fig. 11 is a partial view of a cover structure showing the fiber mesh net of the present invention insert molded into the cover structure;

Fig. 12 is a somewhat schematic cutaway profile exploded view of an insert molded fiber mesh net cover structure co-acting with a case to provide EMI shielding;

Fig. 13 illustrates a preformed, molded fiber mesh net for insertion into a receiving cavity in a cover structure;

Fig. 14 is a somewhat schematic edge end view of the fiber mesh net shown in Figs. 1, 4 or 6 laminated onto a polymer film;

Fig. 15 is a somewhat schematic profile view showing the fiber mesh net laminated to one surface of a polymer film and electrical circuitry carried on the opposite surface of the polymer film;

Fig. 16 is a somewhat schematic cutaway profile view of a cover structure with the insert molded fiber mesh net embodiment of the invention shown in Fig.15;

Fig. 17 is a fragmentary, exploded partial view of a portable electronic device wherein a fiber mesh net is laminated on one surface of a polymer film and electronic circuitry is carried on the side opposite to extend circuit functionality to the cover;

Fig. 18 shows at least one thread of the fiber mesh net wrapped around a conductive post for electrical connection to a printed circuit board;

Fig. 19 shows at least one thread of the fiber mesh net attached to a pin for electrical connection to a printed circuit board.

Detailed Description of Preferred Embodiments

Turning now to the drawings and referring to Figs. 1-7, a fiber mesh net of the type contemplated by the present invention is shown therein and designated generally at 10. The fiber mesh net 10 is typically made up of a number of electrically conductive fibers or strands 12, 12 which are intertwisted to form threads 14, 14. The threads 14, 14 are woven or knit in a repetitive pattern to form a sheetlike structure such as the one shown in Fig. 1. A further magnified view of a section of a fiber mesh net of the type which may be practiced with the present invention is shown in Fig. 4 and designated generally at 20. A magnified view of a section of the fiber mesh net 20 is shown in Fig. 5. As can be seen in Fig. 5, the threads 14, 14 are woven in a similar pattern as shown in Fig. 2 for the fiber mesh net 10 shown in Fig. 1. Fig. 6 illustrates a yet further example of a fiber mesh net of the type which may be practiced in the present invention and is designated generally at 30. A magnified view of a section of the fiber mesh net 30 illustrated in Fig. 6 and shown in Fig. 7 shows the pattern of woven threads of the fiber mesh net 30. The fiber mesh net 30 illustrated in Fig. 6 and its corresponding magnified pattern illustrated in Fig. 7 differ from the fiber mesh nets 10, 20 illustrated in Figs. 1 and 4, respectively in that the threads 14, 14 are not intertwisted with threads 32, 32 but are rather held in position by virtue of the threads 32, 32 and form what is known as a bobbinet woven fiber mesh. The

resulting fiber mesh net fabric is called a bobbinet. A bobbinet is defined as a set of hexagonal mesh and as can be seen from the magnified views of Figs. 2, 5 and 7, the repetitive patterns are six-sided with each side being designated generally a, b, c, d, e, f, respectively as shown therein. Each of the respective patterns define an opening designated generally at 11, 21, 31 in Figs. 2, 5 and 7, respectively.

In one preferred embodiment, the fiber mesh net is a bobbinet woven 3-directional net having 6 to 34 openings per inch and a specific weight of 10 to 50 grams per square meter. Although the fiber mesh nets 10, 20, 30 are preferably a bobbinet woven fiber mesh net, other textile structures, such as warp knitted, woven, Raschel, braided, nonwoven or spun multidirectional structures providing the desired electrically conductive EMI shielding characteristics are also useable to provide the EMI shielding structure of the present invention. Raschel is characterized by warp knitting with needle bars, latch needles and removal and holding cams as known by those skilled in the art of knitting.

Fig. 8 illustrates a somewhat schematic edge end view of the fiber mesh nets of Figs. 1, 4 or 6 as showing the terminal ends of the threads 14, 14. Although the threads 14, 14 are shown as multiple intertwisted strands, the threads can be a single strand or fiber.

The shielding effectiveness of the fiber mesh net of the present invention is dependent upon and related to the fiber material and thickness or diameter of the fiber. The fiber material may be natural or synthetic, metal or alloy, conductive or non-conductive, or conductively coated non-conductive material. For example, the fiber mesh may be made of natural fibers or filaments such as cotton and other cellulose fibers, silk

or other protein fibers and glass or other ceramic fibers. The fiber mesh may also be made of man-made synthetic, regenerated or metal fibers and filaments, for example, polyesters, polyamides, polypropylenes, polyethylenes and cellulosics such as PES (poly(ethylene terephthalate) and other polyesters from diols and terephthalic and other acids), PA6.6 [poly(hexamethylene adipamide)], PA6 [poly(ε-caprolatam)], PP (polypropylene or polypropene) and copper. Fibers, filaments, and yarns can be coated by a thin conductive metal layer having an approximate thickness of 10 to 10000nm, and preferably the conductive metal layer a silver, nickel or aluminum layer. The fiber fineness can be varied from 0.05 den (0.055 dtex) microfibers to 100 den (110 dtex) monofilament whereas the yarn fineness can be extended according to the mesh type up to 300 den (33 tex).

The abbreviations used above are defined as follows. Den is an abbreviation for denier which is a unit of fineness or linear density for yarn or fiber equal to the fineness of a yarn or fiber weighing one gram for each 9000 meters. Dtex is an abbreviation for decitex which is a unit of fineness or linear density for yarn or fiber equal to the fineness of a yarn or fiber weighing one gram for each 10,000 meters. Tex is a unit of fineness or linear density for yarn or fiber equal to the fineness of a yarn or fiber weighing one gram for each 1,000 meters.

Test measurements of the fiber mesh net 10 made of a PET - Ag blend resulted in a shielding effectiveness of 39.7 dBm at 1 GHz. Test measurements of the fiber mesh net 20 made of a polyamide PA and silver-coated polyamide (PA - Ag) combination with a weight of 21 grams/meter^2 and 0.1 millimeter diameter resulted in a shielding effectiveness of 34.0 dBm at 1 GHz. Test measurements of

the fiber mesh net 30 made of a PA and (PA - Ag) combination with a weight of 17 grams/meter^2 and 0.6 millimeter diameter resulted in a shielding effectiveness of 31.1 dBm at 1 GHz.

Now referring to Figs. 9, 10 and 11, the EMI shielding system of the present invention is further explained with reference to the figures. Fig. 9 shows a somewhat schematic cutaway profile view of a cover structure or housing shell 40 wherein the fiber mesh net designated generally at 42 is shown insert molded into a predefined interior cavity 44 formed by the wall 46 of the cover and internal walls 48, 50 of the inner side or electronic circuitry facing side 52 of the cover 40. The interior cavity 44 is positioned in the cover to enclose the area of the electronic circuitry within the electronic device that is desired to be EMI shielded when the cover is placed on a receiving housing shell or base structure (not shown) of the electronic device. As illustrated in Fig. 9, the fiber mesh net 42 is insert molded coextensive with the inner surfaces 54, 56, 58 of the walls 48, 46 and 50, respectively defining the interior cavity 44. A portion 60, 62 of the peripheral edge ends of the fiber mesh net 42 extend to a lower surface 64, 66 of the walls 48, 50 respectively. The fiber mesh net portions 60, 62 are exposed and define a contact surface for mechanical and electrical contact with a ground plane on an electrical printed circuit board (not shown in Fig. 9) to provide the necessary ground voltage potential for effectuating the necessary EMI shielding. The fiber mesh net 42 is insert molded along with the cover 40 such that the fiber mesh net 40 is integrated with the inner surfaces 54, 56, 58 defining the interior cavity 44.

Fig. 10 illustrates conceptually one means for

insert molding the fiber mesh net into a cover structure to form the desired EMI shielding solution described in conjunction with Fig. 9. As illustrated in Fig. 10, a fiber mesh net sheet embodying the invention and generally designated at 70 is positioned above the desired location in the cover structure to be molded by means of a mold designated generally at 72. The mold structure 72 is typically a multi-cavity mold and as illustrated, the particular cavity 74 corresponds to the interior cavity in the cover structure with which the fiber mesh net of the present invention will be insert molded to provide the desired EMI shielding. During the molding process of the cover structure, the fiber mesh net sheet 70 is insert molded in the direction illustrated by the arrows 76, 76 into the mold cavity 74 and fuses with the material of the cover structure along the inner surfaces of the cover cavity. The resulting cover structure is illustrated in Fig. 11 and designated generally at 80. The insert molded fiber mesh net designated generally at 82 is shown in the interior cavity 84 of the cover structure 80. A portion of the fiber mesh net 82 defining a peripheral edge 86 of the insert molded fiber mesh net 82 is coextensive with and exposed along the surface 88 immediately adjacent to the cavity 84. Although the fiber mesh net surface is illustrated as being exposed or partially exposed within the interior cavity 84, the fiber mesh net 82 can be totally covered by and within the material forming the cover structure 80. The depth that the fiber mesh net 82 is inserted into the mold cavity can be controlled as required for the particular designed cover structure.

A somewhat schematic profile cutaway view of the cover structure 80 is illustrated in Fig. 12 to show how the cover 80 co-acts with a receiving housing shell or

base structure generally designated at 90 of the electronic device. The housing shell 90 carries a printed circuit board 92 upon which electronic circuitry components 94, 94 are carried and which components 94, 94 are to be EMI shielded. The printed circuit board 92 has a ground plane 96 on the surface 98 facing the cover structure 80. When the cover structure 80 is placed in co-acting relationship with the housing shell 90 as illustrated by the direction arrows 100, 100 the edge portion 86 of the fiber mesh net 82 insert molded in the interior cavity 84 makes mechanical and electrical contact with the ground plane 96 of the circuit board 92 and provides the required EMI shielding.

Turning now to Fig. 13, a further embodiment of the present invention is illustrated therein wherein the fiber mesh net EMI shielding structure embodying the present invention is illustrated therein and designated generally at 110. The fiber mesh net 110 is illustrated in this embodiment as a preformed molded piece to conform to the shape, size and contour of a corresponding interior cavity 112 of a cover structure 116 such as for example, the type used to encase a portable electronic device such as a cellular or radio telephone. In the embodiment illustrated in Fig. 13, the fiber mesh net 110 is formed such that it provides an outer peripheral flange or lip 118 having a lower surface 124 which rests on a corresponding peripheral surface region 120 located on the surface 114 surrounding the cavity 112. When the fiber mesh net mold 110 is inserted into the cavity 112 as indicated by the direction arrow 122, the electrically conductive fibers of the fiber mesh net mold 110 along the peripheral surface 126 are positioned in facing relationship with a printed circuit board ground plane (not shown in Fig. 13) similar to the configuration as

illustrated in connection with the explanation of Fig. 12. The fiber mesh net mold 110 is maintained within the cavity 112 through surface-to-surface engagement however, preferably through suitable bonding means.

To facilitate ease of handling of the fiber mesh net it may be desirable to join the fiber mesh net shown in Figs. 1, 4 or 6 with a polymer film layer to form a laminate such as illustrated in a somewhat schematic edge end view in Fig. 14. The polymer film layer designated generally at 130 and the fiber mesh net designated generally at 132 is located on and bonded to the surface 134 of the polymer film layer 130. The laminate generally designated at 136 formed by the polymer film layer 130 and the fiber mesh net 132 is such that at least a portion of the fiber mesh net surface is exposed for mechanical and electrical connection to the ground plane on a printed circuit board as explained above and further to provide flexibility and insert molding into an interior cavity defined in a cover structure as disclosed and described above.

Turning now to Fig. 15, a further embodiment of the EMI shielding structure of the present invention designated generally at 141 is illustrated therein. In Fig. 15, a somewhat schematic profile view shows a fiber mesh net generally designated at 140 laminated to the inner surfaces 142, 144, 146 of the walls 148, 150, 152, respectively defining an interior cavity generally designated at 154. The end portions 156, 158 of the fiber mesh net 140 extend around the lower end surface 160, 162 of the wall 148, 150, respectively. The end portions 156, 158 contact a ground plane or ground circuit path of a printed circuit board (not illustrated in Fig. 15) to provide the necessary electrical ground potential for proper EMI shielding. Electrical circuitry

shown schematically at generally designated 164 is carried on a surface 166 opposite the surface 144 upon which surface 144 the fiber mesh net 140 is laminated. The fiber mesh net 140 at the end portion 156 extends across the lower end surface 160 into electrical contact with the circuitry 164 at a connection point generally designated at 168. It should be noted that the electrical circuitry 164 carried on the surface 166 does not extend completely across the polymer film surface 166 to the end portion 158 of the fiber mesh net 140. In the embodiment shown in Fig. 15, the electrical ground potential is carried from the printed circuit board ground plane to the electrical circuitry 164 when the cover is in place as described herein above.

As described herein below, the electrical circuitry can also be used to provide a ground voltage potential connection for additional components located remote from the printed circuit board carried in the housing shell of the electronic device and external to the cover structure. Selected strands of the fiber mesh net 140 are electrically coupled to the electrical circuitry 164 carried by the surface 166 of the polymer layer 143. The EMI shielding structure 141 of Fig. 15 can be pre-shaped or pre-formed to conform to the contours of the cavity into which the EMI shielding structure is insert molded such as the interior cavity in a cover structure as described above.

Fig. 16 shows a somewhat schematic cutaway profile view of a cover structure generally designated at 170 and which cover is similar to the cover structure illustrated in Fig. 9. A polymer film laminated with a fiber mesh net 140 on one surface 144 and electrical circuitry 164 on its opposite surface as described in connection with Fig. 15 is insert molded into a predefined interior

cavity 172 formed by the wall 174 of the cover 170 and inner walls 176, 178 on the interior side 180 of the cover 170. The interior cavity 172 is positioned to enclose the area of the electronic circuitry carried on a printed circuit board (not illustrated in Fig. 16) that is desired to be EMI shielded. As illustrated in Fig. 16, the fiber mesh net 140 is coextensive with the inner surfaces 142, 144, 146 of the walls 174, 176, 178, respectively defining the cavity 172. The end portions 156, 158 of the fiber mesh net 140 are left exposed for electrical and mechanical contact with the ground plane on a printed circuit board as explained above in connection with Fig. 12.

Turning now to Fig. 17, a further embodiment of the present invention is illustrated therein as it may be practiced with a portable electronic device such as a cellular or radio telephone. A printed circuit board 190 carrying electronic circuitry including components 192, 192 that generate and emit electromagnetic radiation is supported by and carried within a housing shell of the electronic device (not illustrated in Fig. 17). The ground voltage potential circuit path or ground plane 194 is carried on the surface 196 of the printed circuit board 190. A somewhat schematic fragmentary view of a cover generally designated at 200 in which the fiber mesh net 202 of the present invention is injected molded therein, is shown positioned above the electronic components 192, 192 such that when the cover 200 is placed into position with and attached to the housing shell, the outer peripheral lower edge surface 204 of the fiber mesh net 202 will come into mechanical and electrical contact with the ground plane 194 carried by the printed circuit board surface 196 to provide the necessary electrical ground for the desired EMI

shielding.

As further illustrated in Fig. 17, additional electronic circuitry designated generally at 206 is carried on the upward outwardly facing surface 208 and co-acts with an additional laminate overlay generally designated at 210 which may, for example, carry the keys 212, 212 of a dialing pad of the cellular or radio telephone. In the embodiment illustrated in Fig. 17, the additional electronic circuitry 206 carried on the upper surface 208 of the fiber mesh net and polymer film laminate 202 is accessible to the laminate overlay 210 through an appropriately sized and shaped open portion 214 in the cover 200. Although the electronic circuitry 206 carried on the outer surface 208 of the laminate 202 illustrated in Fig. 17 is to provide a ground voltage potential for a keypad laminate overlay 210, additional functional circuitry can be carried on the surface 208 and interconnected with other electronic circuitry 216 carried on the printed circuit board 190 to provide additional functions and/or to provide additional mounting area for the functional electronic circuitry of the cellular or radio telephone. The techniques for applying printed circuit paths and ground planes using conductive inks and interconnection with electrical circuit components are well known to those skilled in the art of producing electronic circuitry on a flexible circuit substrate.

Appropriate and desired electronic signals are carried to and from the printed circuit board circuitry components 216 via specific conductive fibers that are pre-identified and fabricated as part of the fiber mesh net of the present invention. Certain of the threads, for example thread 32, as illustrated in Fig. 7 may carry an insulated outer jacket over an electrical current

carrying center conductor through which the electronic signals may pass back and forth from circuitry 216 on the printed circuit board 190 and circuitry 206 on the laminate surface 208. The terminating end of the conductor may be connected to the printed circuit board through various means well known to those skilled in the art for example, as illustrated in Figs. 18 and 19. Fig. 18 illustrates a wrapping technique wherein the conductor 220 is wound around a stake or post 222 to make electrical and mechanical connection with the post. The post 222 is then inserted into an appropriate mating receiving connector 224 mounted on the printed circuit board 190. Fig. 19 shows a conductor end 226 received into an end 228 of a pin 230 and which pin 230 is in turn inserted into an appropriate mating receiving connector 232 mounted on the printed circuit board 190. Appropriate miniaturization techniques such as ultrasonic welding can be used to increase the density of connection points from and to fibers of the fiber mesh net.

An EMI shielding structure embodying the present invention has been illustrated above in several preferred embodiments. It will be appreciated and understood that numerous modifications may be made by those skilled in the art without departing from the spirit and scope of the invention as presented. Therefore, the present invention has been shown by way of illustration rather than limitation.

The invention claimed

1. Method for EMI shielding a portable electronic device characterized by insert molding an electrically conductive fiber mesh net into a wall of said device to shield first electronic circuitry contained within said device.

2. Method for EMI shielding a portable electronic device as set forth in claim 1 further characterized in that at least a portion of said fiber mesh net is brought into direct continuous physical and electrical contact with a ground plane carried on a circuit board substrate within said electronic device.

3. Method for EMI shielding a portable electronic device as set forth in claim 1 further characterized in that said fiber mesh net is laminated to a polymer film sheet.

4. Method for EMI shielding a portable electronic device as set forth in claim 3 further characterized in that said polymer film sheet has an electrically non-conductive surface opposite said fiber mesh net surface for carrying second electronic circuitry, said fiber mesh net having at least a portion extending to the non-conductive side for mechanical and electrical coupling to said second electronic circuitry.

5. Method for EMI shielding a portable electronic device as set forth in claim 4 wherein said fiber mesh net is further characterized by part of said fiber mesh net being a mixture of conductive and

non-conductive fibers, at least one of said conductive fibers carrying electrical signals from said first electronic circuitry on said printed circuit board to said second electronic circuitry.

6. Method for EMI shielding a portable electronic device characterized by insert molding an electrically conductive fiber mesh net into a wall surface defining an interior cavity surrounding first electronic circuitry contained within said device further characterized by providing a bobbinet woven fiber mesh net.

7. Method for EMI shielding a portable electronic device as set forth in claim 6 further characterized by providing a fiber mesh net comprising a textile structure including warp knitted, woven, Raschel, braided, nonwoven and spun multidirectional textile structures.

8. EMI shielding apparatus for a portable electronic device characterized by an electrically conductive fiber mesh net insert molded into wall surfaces defining an interior cavity of said electronic device, said cavity having a size, shape and contour to surround first electronic circuitry within said electronic device.

9. EMI shielding apparatus as set forth in claim 8 further characterized in that at least a portion of said insert molded electrically conductive fiber mesh net is in a substantially continuous physical and electrical contact with a ground plane carried on a circuit board substrate within said electrical device.

10. EMI shielding apparatus as set forth in claim 9 further characterized in that said fiber mesh net is a bobbinet woven fiber mesh net.

11. EMI shielding apparatus as set forth in claim 9 further characterized in that said fiber mesh net is a bobbinet woven 3-directional fiber mesh net.

12. EMI shielding apparatus as set forth in claim 8 further characterized in that said fiber mesh net comprises a textile structure mesh net including at least warp knitted, woven, Raschel, braided, nonwoven and spun multidirectional fiber mesh nets.

13. EMI shielding apparatus as set forth in claim 8 further characterized in that said fiber mesh net is laminated to a polymer film sheet.

14. EMI shielding apparatus as set forth in claim 13 further characterized in that said polymer film sheet has an electrically non-conductive surface opposite said fiber mesh net surface for carrying second electronic circuitry, and said fiber mesh net having at least a portion electrically coupled

to said second electronic circuitry and to first electronic circuitry within said electrical device for passing electronic signals between said first and second electronic circuitry.

15. EMI shielding apparatus as set forth in claim 11 further characterized in that said bobbinet woven 3-directional fiber mesh net is characterized by 6 to 34 openings per inch and a specific weight of 10 to 50 grams per square meter.

16. EMI shielding apparatus as set forth in claim 8 further characterized in that said fiber mesh net is preformed to the size, shape and contour of said interior cavity for insert molding therein.

17. EMI shielding apparatus as set forth in claim 14 further characterized in that said fiber mesh net is inserted molded into a cover portion of said electrical device such that said second electronic circuitry is electronically coupled to other electronic circuitry carried on the exterior of said cover and arranged for functional co-action with said second electrical circuitry to pass electrical signals between said other and said second circuitry.

Abstract of the Disclosure

A fiber mesh net is insert molded into an interior cavity of a cover structure of a portable electronic device such as a cellular or radio telephone to provide EMI shielding. The fiber mesh net is also bonded to one surface of a polymer sheet which additionally carries electronic circuitry on its opposite side to form a laminate which is inserted molded into a cover structure to extend electrical circuitry functionality via selected fibers of the fiber mesh net for access from the electronic device cover.

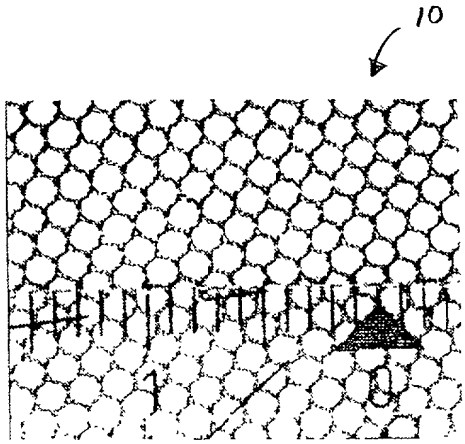


FIG. 1

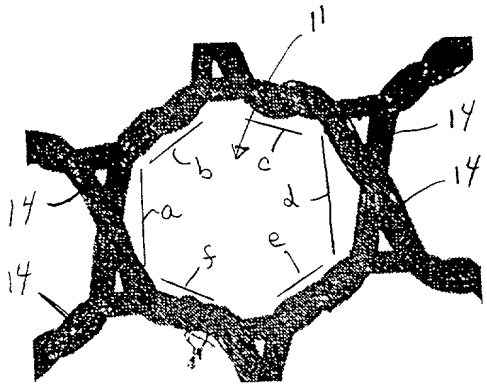


FIG. 2

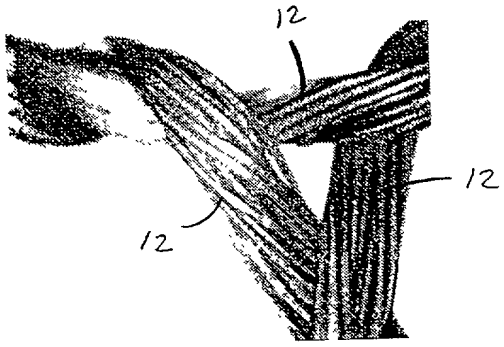


FIG. 3

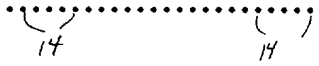


FIG. 8

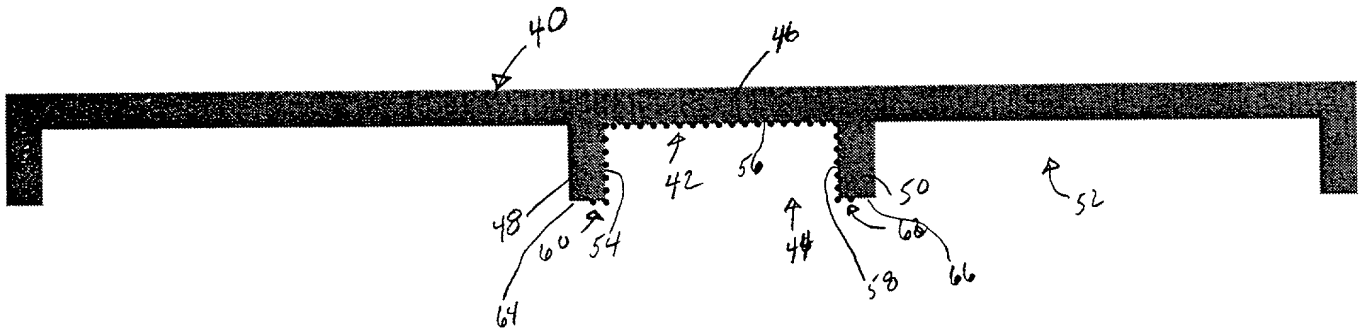


FIG. 9

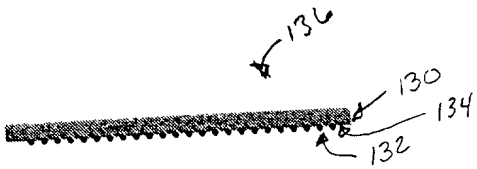


FIG 14

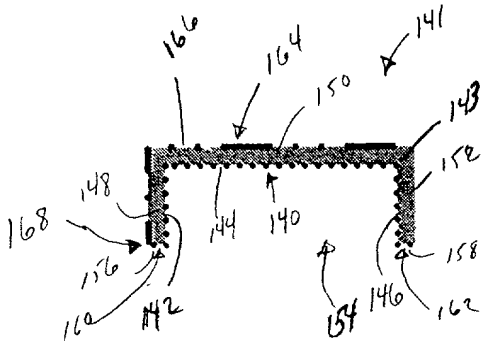
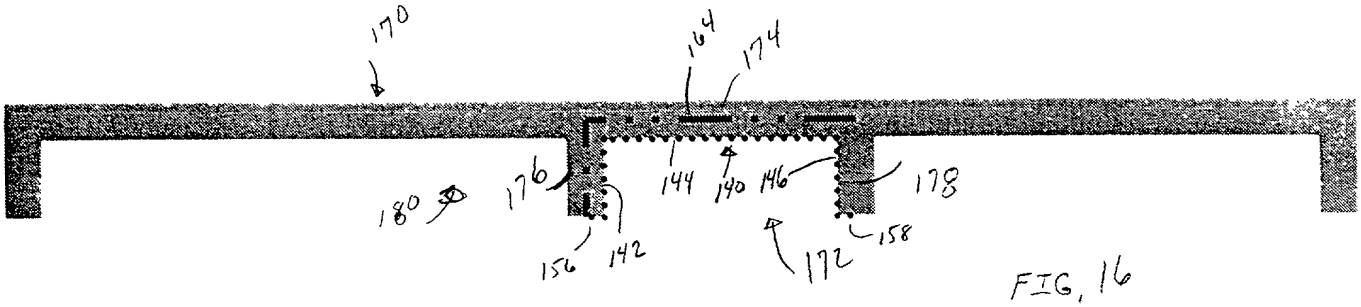


FIG. 15



FIG, 16

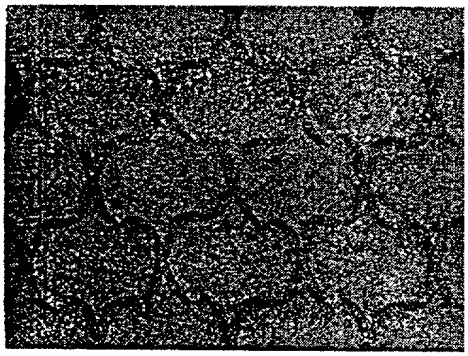


FIG. 4

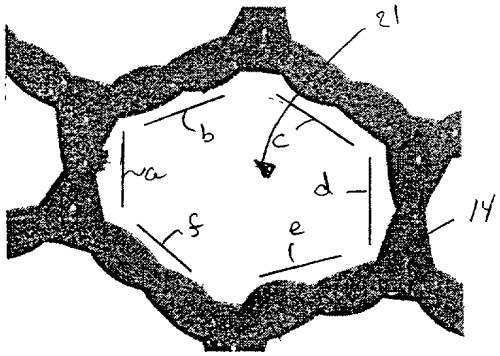


FIG. 5

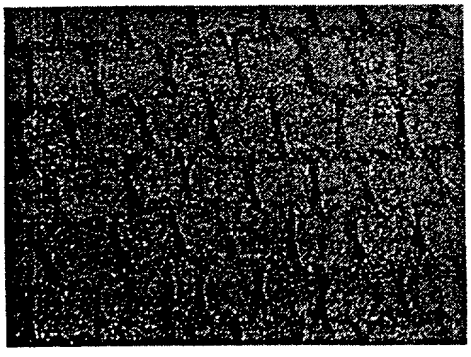
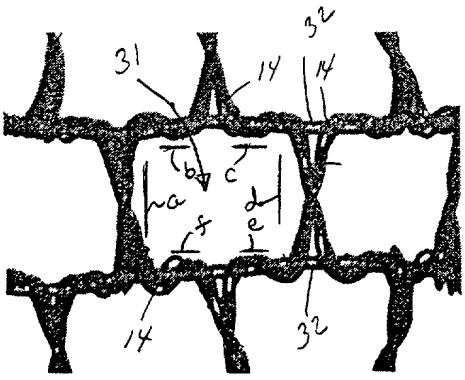


FIG. 6



FIG, 7

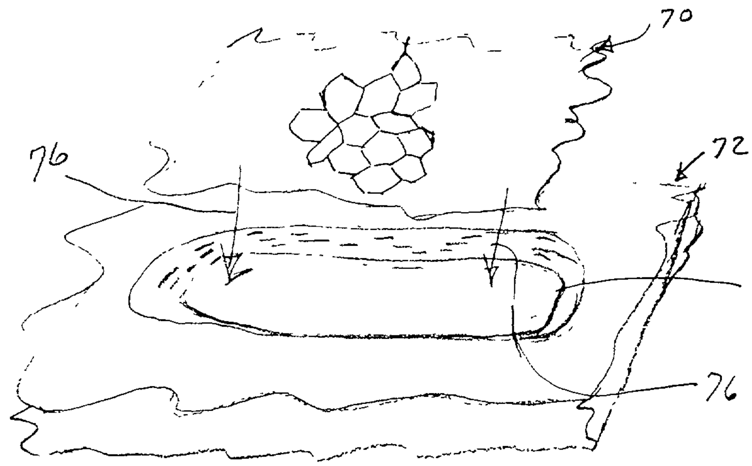


FIG. 10

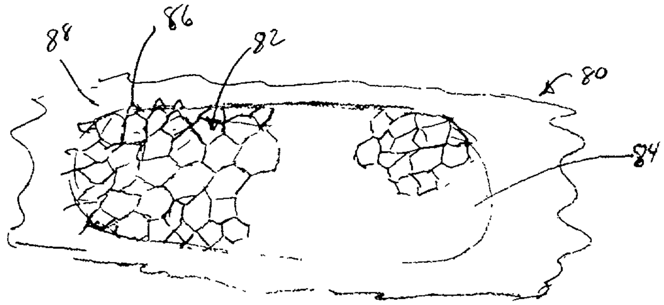


FIG. 11

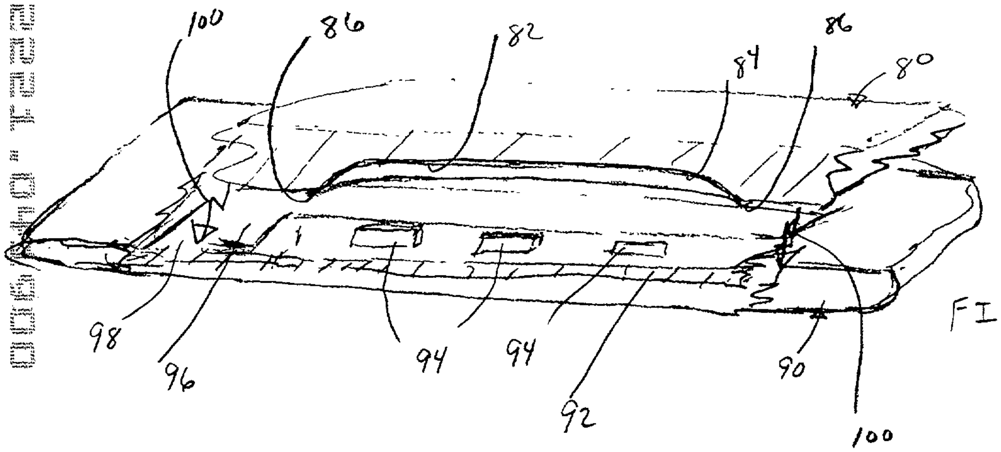


FIG. 12

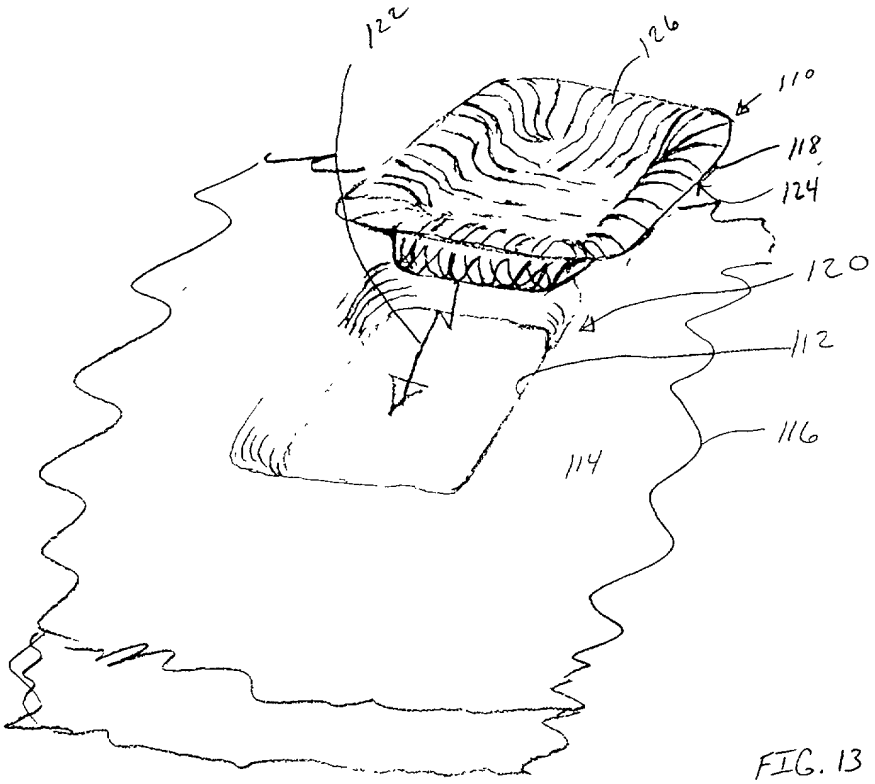


FIG. 13

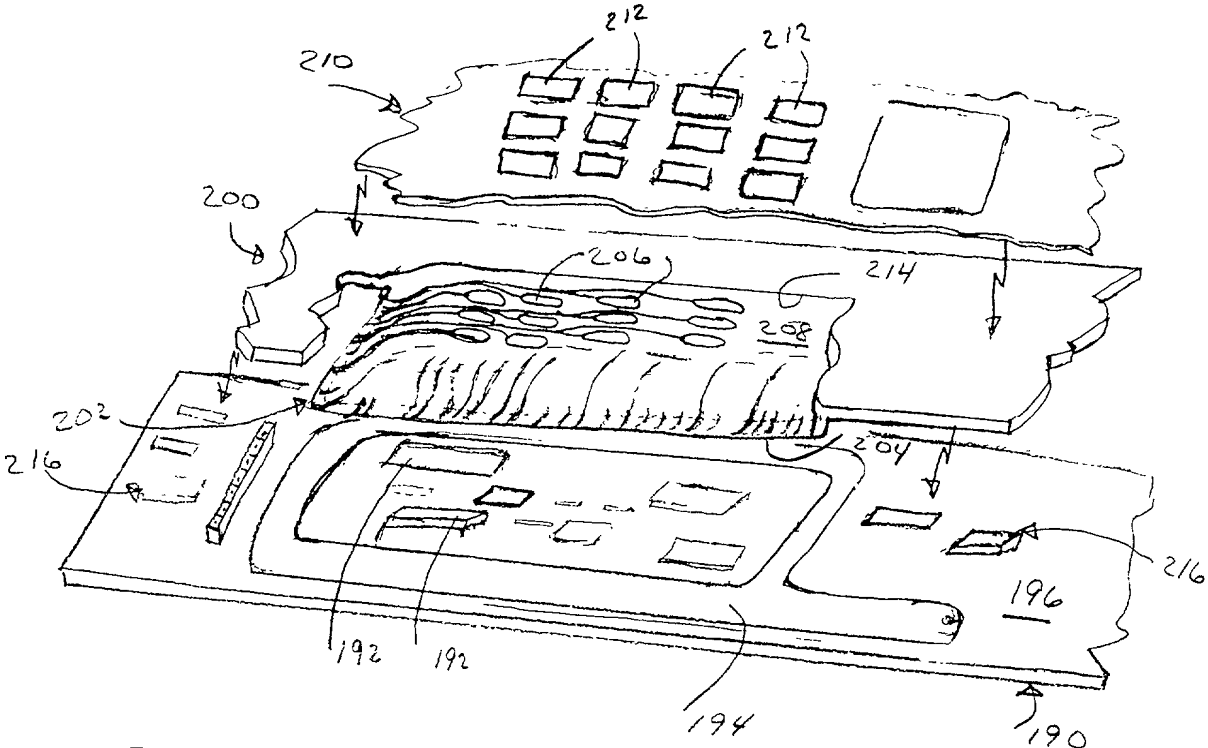


FIG. 17

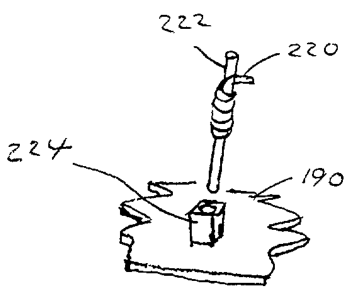


FIG 18

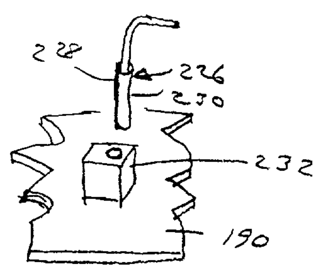


FIG. 19